

The Undo logo, featuring the word "undo" in a blue sans-serif font with a circular arrow icon around the letter 'o', is centered within a white circle.

**undo™**

A woman with dark hair, wearing a teal top and a ring, is smiling and looking to the right. She is holding a large blue circle that contains the main text of the advertisement.

# Improving software quality in SAP HANA

with Live Recorder from Undo

The SAP logo, consisting of the letters "SAP" in white on a blue background with a white triangle pointing to the right.

**SAP**

The logo for 'undo' is a blue circle containing the word 'undo' in white lowercase letters. The letter 'o' has a small white circular arrow icon inside it, pointing clockwise.

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A large, dark blue circle that overlaps with a smaller, medium blue circle to its right. The text is positioned inside the dark blue circle.

**SAP** is the market leader in enterprise application software. It helps 437,000 businesses across 180 countries manage their business operations and customer relations.

The SAP logo, consisting of the letters 'SAP' in white, bold, sans-serif font, set against a blue trapezoidal background that tapers to the right.

**SAP**

Its flagship product is **SAP HANA** - a scalable, heavily multi-threaded, feature-rich in-memory database built from millions of lines of highly-optimized Linux C++ code.

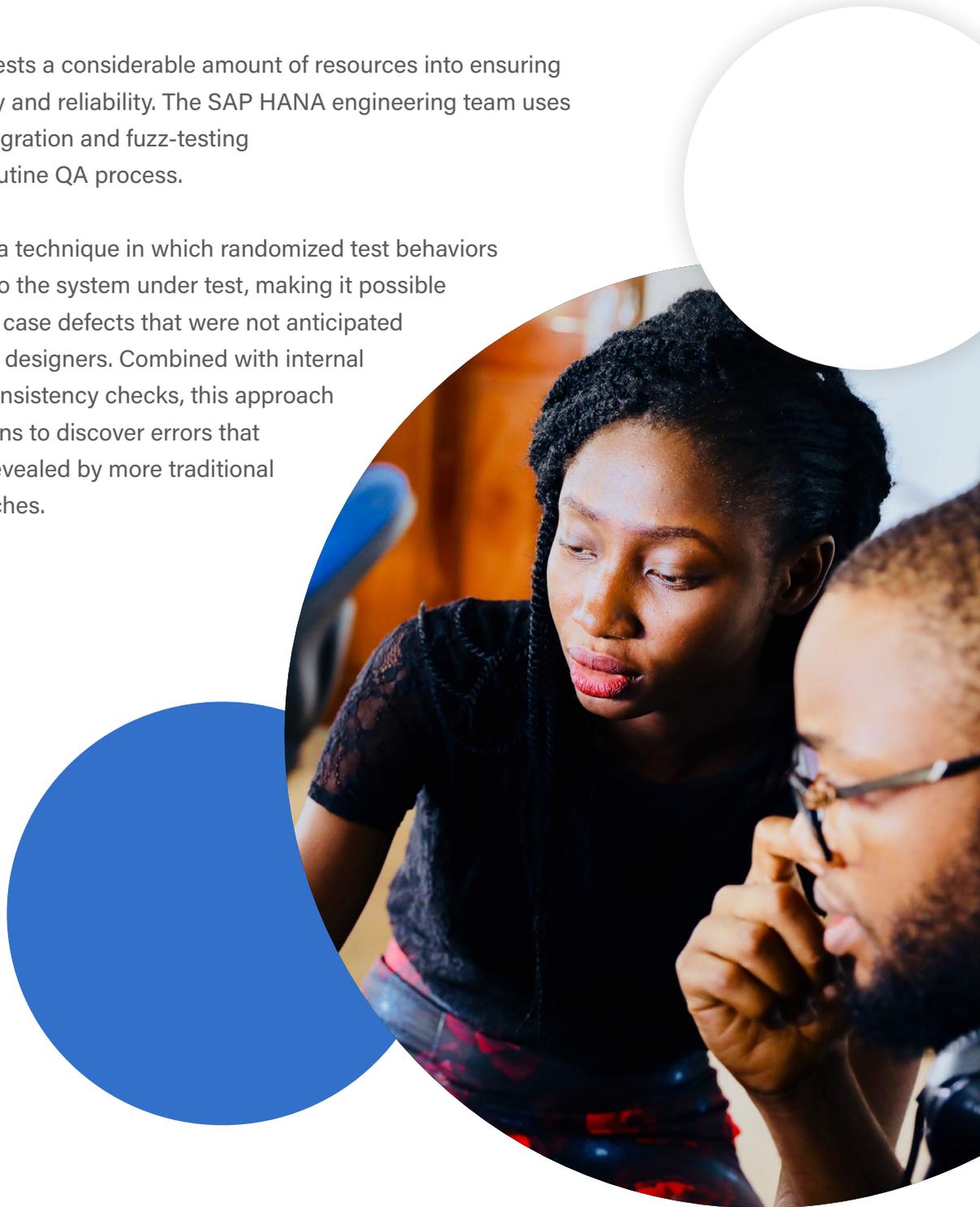
SAP HANA forms the foundation of SAP's technology stack and its product portfolio. It is the backbone of major businesses worldwide - making quality, stability and reliability a core requirement for the engineering team.

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# A comprehensive approach to testing

SAP HANA invests a considerable amount of resources into ensuring software quality and reliability. The SAP HANA engineering team uses continuous integration and fuzz-testing as part of its routine QA process.

Fuzz-testing is a technique in which randomized test behaviors are presented to the system under test, making it possible to catch corner case defects that were not anticipated by the system's designers. Combined with internal and external consistency checks, this approach provides a means to discover errors that would not be revealed by more traditional testing approaches.



	Te Un		Te Un	 <b>Test status: failed</b> Unknown cause. Test run Sept 03
	Te Te		Te Un	 <b>Test status: failed</b> Unknown cause. Test run Sept 14
	Te Un		Te Un	 <b>Test status: success</b> Test run Sept 07
	Te Un		Te Te	 <b>Test status: failed</b> Unknown cause. Test run Sept 18

# The challenge

However, the resulting test failures proved challenging to diagnose, due to a set of factors that are familiar to modern software vendors:

## Complex control flow

Difficult to make inferences about how a failure unfolded

## Huge code base

Collaboration across team is essential to pinpoint a bug

## Non-deterministic failures

Difficult to reproduce reliably in order to investigate the root cause

The non-deterministic nature of many of SAP HANA's test failures means these failures could not be reliably reproduced on a developer's machine for debugging.

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“ The non-deterministic nature of many of SAP HANA's test failures means these **failures could not be reliably reproduced** on a developer's machine for debugging. ”

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# Traditional software defect resolution methods were not satisfactory

Before approaching Undo, SAP HANA developers investigated test failures using three primary methods:

## Analyzing logs from failed runs

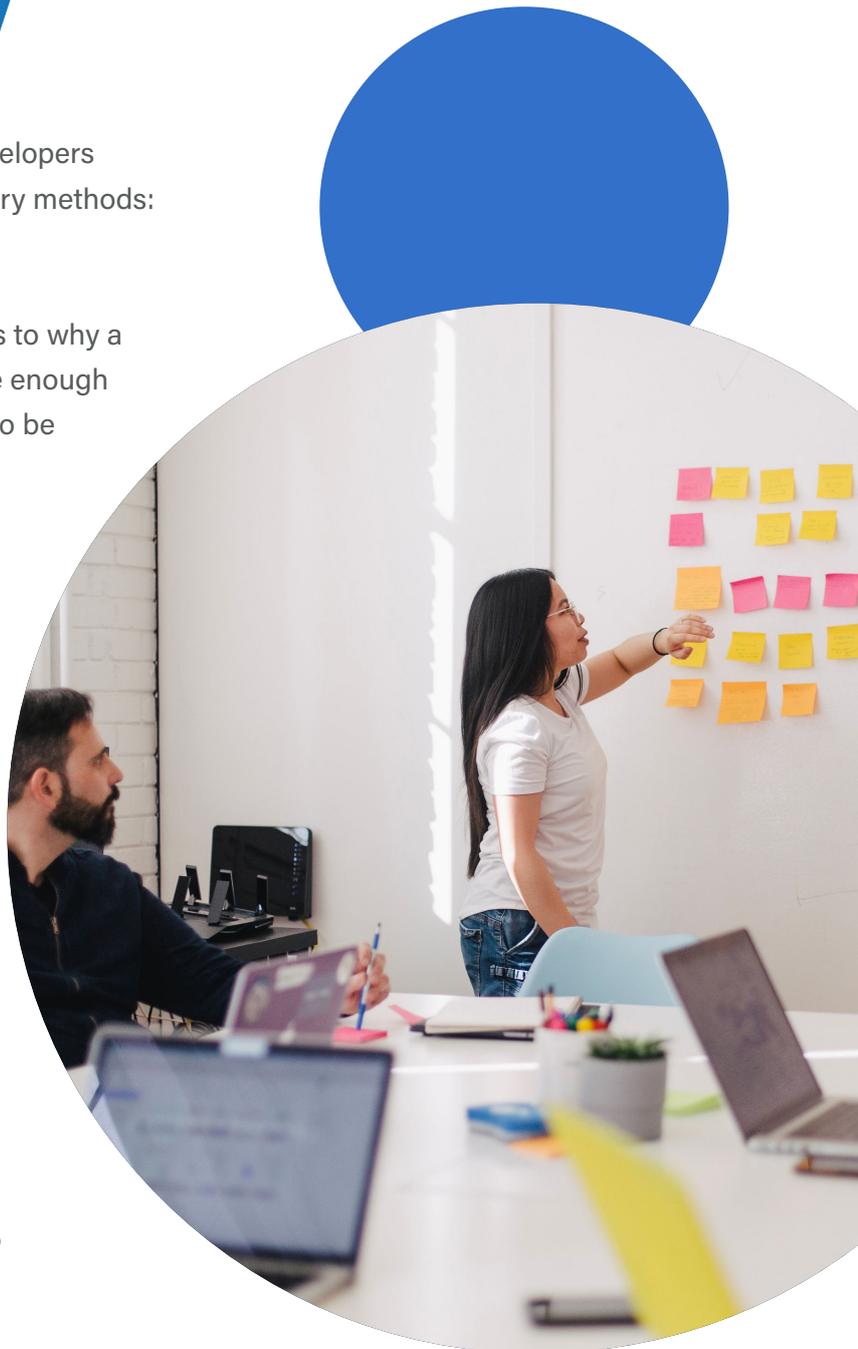
Logs helped to produce a partial picture as to why a failure happened, but often did not capture enough of the right information for the root cause to be easily identifiable.

## Reproducing failures on live systems

For complex problems that needed to be debugged within a running system, a developer had to reproduce the original failure on a live system - which for rare faults was a time-consuming and unproductive use of resources.

## Developer collaboration

When the above methods did not help, a group of developers with specialized knowledge would work together to figure out the source of the problem. But developers could not reliably reproduce test failures on more than one machine; so developers often did not see the same program behavior.



# Solution: software flight recording technology

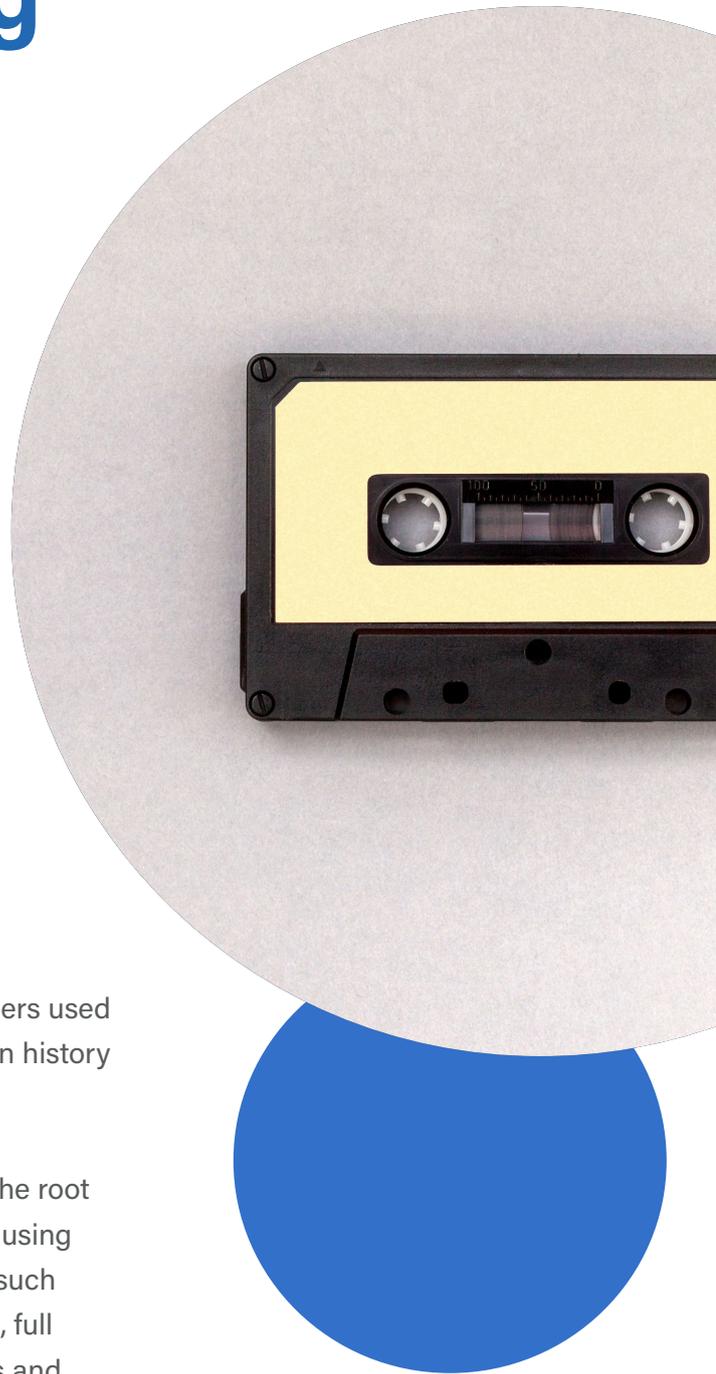
SAP HANA identified Live Recorder from Undo as a solution to make test failure results actionable by “closing the loop” between the defect manifesting itself and the root cause being understood.

The aim was to **reduce time to resolution of software defects and resolve the most challenging defects which could not be diagnosed any other way.**

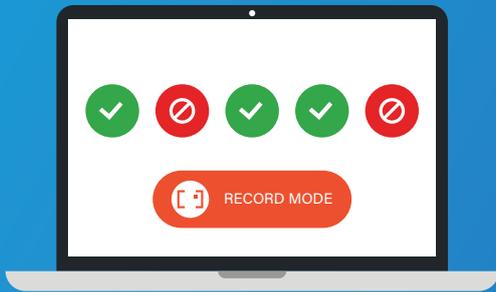
Live Recorder was used to **record failed processes in test and capture failures ‘in the act’** - providing engineers with a standalone, reproducible test case in the form of a recording artifact.

Recording files were then loaded up in UndoDB (Live Recorder’s reverse debugging capability); and engineers used UndoDB to replay the recording and analyze execution history by inspecting the program state at any point in time.

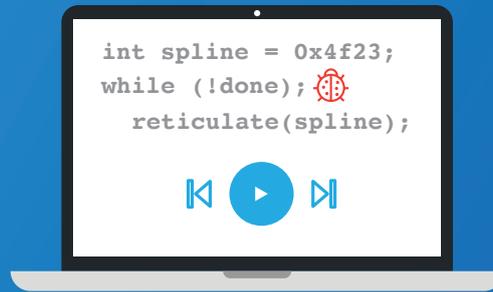
The SAP HANA team was able to quickly hone in on the root cause of defects by navigating to the point of interest using the full functionality expected of modern debuggers (such as scripting, conditional breakpoints and watchpoints, full inspection of globals and locals, etc.) in both forwards and reverse execution.



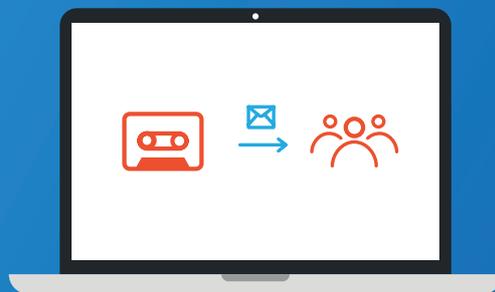
### 1. Record test runs



### 2. Share recordings with development



### 3. Analyze recording down to instruction level



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Live Recorder **captures all non-deterministic data** (down to instruction level) and **recreates the process' entire memory and register state** - on demand and with minimal overhead.

Recordings can then be shared among engineers and analyzed on a different machine to the one on which the error occurred.

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# Debugging with Live Recorder

Live Recorder can be activated with one simple command - making it easy to use Undo's technology with minimum changes to the SAP HANA team's existing workflow.

Live Recorder generates recordings of every test failure, helping engineers find and fix defects as the software is being written.

Trying to reproduce intermittent defects using traditional methods can take days, sometimes weeks or more ... and often lead to dead ends. Instead, Live Recorder eliminates the guesswork in software defect diagnosis by capturing bugs in the act - turning sporadic failures into 100% reproducible test cases. The SAP HANA engineering team is able to get total visibility into what their program did before it failed and why it failed. It is allowing the team to significantly accelerate software defect resolution, while improving stability and code quality.

Failures no longer need to be replicated on the machine on which they originally occurred: by sharing recordings, engineers can analyze an identical copy of the original failure, while collaborating on a fix. With hundreds of developers working on the SAP HANA database across multiple countries, the SAP HANA engineering team can overcome language, communication and time-zone barriers when fixing software defects - further **enhancing the team's responsiveness to issues that appear in testing and speeding up the development cycle.**



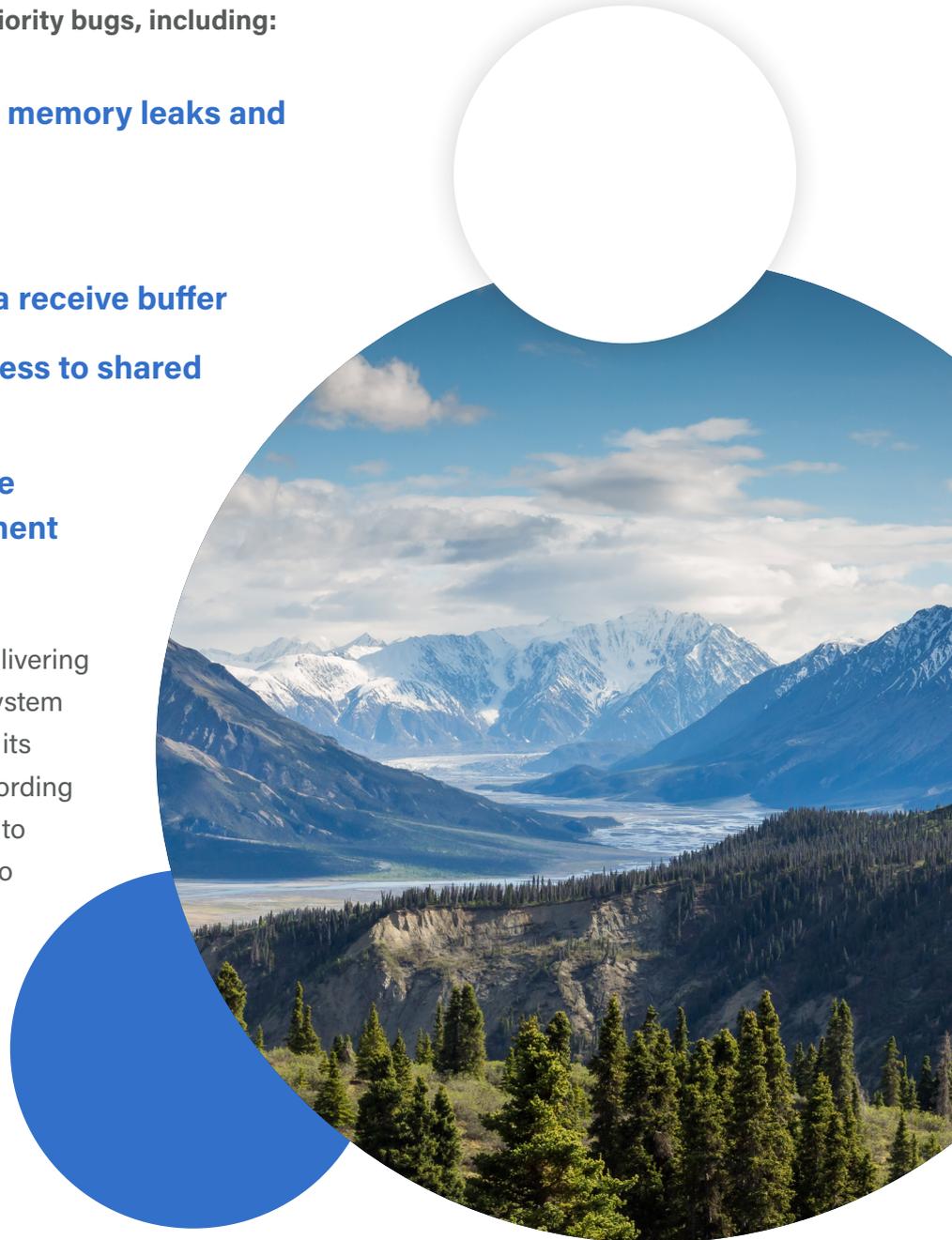
# Outcomes

Live Recorder from Undo has helped SAP HANA accelerate software defect resolution by eliminating the guesswork in software failure diagnosis.

In addition to this, SAP HANA engineers managed to **capture and fix 7 challenging high-priority bugs, including:**

- **a number of sporadic memory leaks and memory**
- **corruption defects**
- **incorrect flushing of a receive buffer**
- **incorrect parallel access to shared data-structure**
- **a race condition in the transaction management cache**

SAP HANA is committed to delivering a reliable data management system their customers can trust; and its adoption of software flight recording technology allows SAP HANA to deliver their latest innovation to customers faster.



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“ With Live Recorder, we were able to **dramatically cut down the analysis time** that is required to understand the root cause of very complex software defects. ”

Dr. Alexander Böhm  
Chief Development Architect, SAP HANA

The SAP logo consists of the letters 'SAP' in white, bold, uppercase font, set against a blue square background with a white diagonal line running from the top-left to the bottom-right.

SAP

Learn more on <https://undo.io>

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